THE RELATION OF VARIATIONS IN THE LEVEL OF THE GROUND-WATER TO THE INCIDENCE AND SEASONAL DISTRIBUTION OF MALARIAL FEVERS IN INDIA.

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THE RELATION OF VARIATIONS IN THE LEVEL OF THE GROUND-WATER TO THE INCIDENCE AND SEASONAL DISTRIBUTION OF MALARIAL FEVERS IN INDIA.[1]

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VARIOUS statements are to be found in the literature of malaria with regard to the influence of rainfall, moisture in the air, and variations of temperature on the occurrence of fever, but very little on the influence of variations of the ground-water. Some observations were, indeed, made by Dr. T. R. Lewis and Brigade-Surgeon-Lieutenant-General D. D. Cunningham on this point in India, but the data they collected were from measurements by many different observers and do not appear to have been made sufficiently regularly or for long enough a time to allow of any very definite conclusions being based on them. Waterlogging of a soil by a constantly high ground-water is too well known a cause of malaria to need more than a passing reference. It is rather in dry places that observations are required and it is chiefly this side of the question that will be dealt with in the present paper. The rainfall is to some extent an index of the variations of the ground-water level, but only partly so. As is well shown in the charts in Davidson's "Diseases of Warm Climates" the maximum fever rate may occur slightly before, with, or after, the maximum rainy season; but I shall hope to show that the differences in this respect depend largely on the distance of the ground-water from the surface before the rainy season begins. Professor Lane Notter, in his well-known book on Hygiene, correctly remarks that "the development of malaria may be connected either with a rise or fall of the ground-water." Hirsch in his "Geographical Pathology" writes: "In the most intensely malarious spots of the tropics the prevalence of the disease is generally associated in a most marked manner with the rainy season. The fever makes its appearance with the commencement of the rains and lasts the whole period. If the rainfall be not excessive, it reaches a maximum usually when the rain ceases and continues with decreasing extent and virulence until the setting in of the cold season." This again is generally true, but with considerable variations in different places; and these variations, I believe, depend chiefly on the depth of the ground-water level and also to some extent on the nature of the soil, especially in relation to its power of retaining moisture. It is more especially in countries where there is an absence of marshy or water-logged soil that our knowledge of the factors which influence the occurrence and distribution of malarial fevers is defective. Chota Nagpur is mentioned by Hirsch as one of the exceptional places where malarial fevers prevail on a dry soil in the absence of marsh or waterlogging.

In 1895 I commenced a series of observations for the purpose of trying to ascertain the causes which influenced the seasonal incidence of malarial fevers in the dry district of Chota Nagpur. My observations were made in Doranda, the cantonment of Ranchi, which is the headquarters of the district. This place is situated on a dry, porous soil and is 2000 ft. above the sea level and my observations were made on some 400 men of the 11th Bengal Infantry, who all lived in lines on a small area of ground. Records were made of the maximum, minimum, and ground temperatures (the latter at a depth of 6 ft.), the rainfall, the moisture in the air, and lastly the level of the water in three wells which immediately surrounded the lines, taken twice a week by means of a float attached to a metallic tape. The average of the distance of the water from the surface of the ground in the three wells was taken to give the level of the ground-water beneath the lines in which the men were living. Notes were taken in shorthand of each man who came to hospital with fever and the day on which he first began to suffer from it was noted. The blood of the majority of the cases was examined for the malarial organism, and its frequent discovery, together with the precisely similar character of the symptoms in all the cases, proved that they were really malarial in thei nature. The fever season in this place is the rainy season, which lasts from the middle of June to the middle of October as a rule, but varies somewhat in different years. More than 80 per cent. of the yearly fever occurs at this time. During the cold weather and the hot, dry months there is very little fever and during these months the ground-water level was from 25 ft. to 35 ft. beneath the surface in these lines. In 1895 the rainy season began about the middle of June and during the latter half of this month very nearly 10 in. of rain fell. The air, from being very dry, became saturated with moisture, the temperature fell some 15° and varied very rapidly, falls of 25° having been registered within a few hours. In short, all the atmospheric conditions were altered but there was no increase in the fever-rate over that of the previous dry hot month of June. The water-level only had not materially changed—that is to say, it had only risen from 35 ft. to 28 ft. from the surface, being still too low to affect the fever-rate.

The subsequent course of the fever and ground-water variations are shown in Chart I. The upper curve shows the variations in the level of the ground-water, while the lower curve illustrates the variations in the average number of fresh cases of fever in the same periods. From July 4th to 13th there was a very heavy rainfall and the water level rose from 28 ft. to 16·5 ft. from the surface. At the same time the fever-rate first began to rise, so that the daily average of fresh cases was 2·16, or fifteen cases in the week, instead of only six cases in the whole of the previous month. Then there was a slight break in the rains and the water fell 7 in. in the next period, which is practically only a cessation in its rise, but immediately the fever-rate fell to one case a day. Then the water rose rapidly once more and with it the fever-rate increased up to 2·5 cases a day, only to decline again with the next fall in the water-level, during the first week in August. Once more the water rose until it was only 5¼ ft. below the surface of the ground on Aug. 18th—that is, a total rise of nearly 30 ft. in eight weeks—and again the fever rose until the average daily number of cases reached three, the highest rate for the whole year. During the next month there was but little rainfall and both the curves steadily declined. In the third week of September, however, there was a fall of 5 in. in two days; the water level once more rose and was again accompanied by a rise in the fever-rate. After this the rains practically ceased and the water fell steadily, with the exception of a very slight rise when it was 13 ft. from the surface, which was apparently too small to influence the fever; and when it had receded to 17 ft. the fever ceased. During the next year observations were taken for me in the same manner by Surgeon-Lieutenant Wilson, of the Indian Medical Service, and a very similar chart was obtained which I unfortunately left behind in India; but I have obtained further confirmation of the relationship between the rise and fall of the water and that of the fever in some tea-gardens in Assam, which I shall come to very shortly.

I must first, however, explain Chart II., which illustrates the monthly fever-rate and the monthly rainfall over a series of ten consecutive years in the same place and among the men of the several regiments who successively lived in the same spot. The first and third lines illustrate the fever-rate, while the second and lowest show the rainfall. The general relationship between the two will be at once apparent, while a closer study reveals several points of interest. In the first place, it will be observed that while the rains usually begin in the month of June the fever does not increase to any extent until a month later. This is due to the fact already mentioned, that the water is always some 35 ft. from the surface of the ground at the commencement of the rainy season (and was still 28 ft. down at the end of June in 1895 although 10 in. of rain had fallen), so that it is not until there has been heavy rain in July on the top of that of June that the ground-water rises high enough to influence the fever-rate. Secondly, it will be noted that in the years of exceptionally heavy rain, such as in 1887, 1894, and 1895, the fever is also unusually great; while in the years 1890, 1891, and 1892, when the rainfall was deficient, the fever-rate was also very low. But in addition to the absolute amount of the rainfall, the regularity or otherwise of its distribution exercises an important influence on the rapidity and extent of the variations of the ground-water and so on the amount of fever. Again, the amount of the rainfall in the seven months preceding the regular rainy season will have some

[1] A paper read before the Epidemiological Society on Feb. 18th, 1898.

effect in so far as it influences the level of the water at the beginning of the rainy season, for if it be then higher than normal a given quantity of rain will have a greater effect in raising the water level near to the surface of the ground. All these factors, however, act by causing a greater or less variation in the water level and all the differences in the amount and distribution of the fever in the years illustrated in the chart can be explained by the combination of these various factors in different degrees. Thus in the years 1886 and 1895 both the rainfall and fever rate were average ones. In 1887 both the rainfall and fever rate were heavy, but the former began very early—namely, in May—and, for the reasons already given, the fever did not increase until July. On the other hand, the rains ceased very early, there being unusually little in September, and the fever season was also a short one. In 1889 the rainfall was unevenly distributed, but its total quantity was not large and the fever was about the average. In 1890 and 1891 both the rainfall and fever rate were low. In 1892 there was a remarkable absence of the usual increase in the fever during the rainy season, which at first sight seems to form an exception to the rule which I am illustrating, but on looking a little more closely it will be found to form a true example of the maxim that it is the exception which proves the rule. Thus in the first this particular place the amount of fever varies in proportion to the amplitude of the variations of the ground-water level, and the first chart points to the relationship of the rise and fall of the ground-water level to the increase and decrease of the incidence of the fever being so definite and constant that the two must be causally connected. The amount and distribution of such fever as occurs in the dry first half of the year remain to be explained. That the small rainfall of this period does not influence it is seen from the fact that in the first half of 1893 there was more rain than usual but very little fever, while, on the other hand, in the same months of 1889 there was very little rain but a good deal of fever. Nor would it be expected that there should be a relationship between the two at this time, for the water-level is always from 25 ft. to 35 ft. down during these months. If, however, the amount of fever in the early dry months of one year be compared with that of the previous rainy season it will be found that the two are in proportion. For example, there was more fever than usual in the early part of the years 1888 and 1894 in correspondence with the high fever rate of the preceding years. On the other hand, there was very little fever in the early part of the years 1891 and 1893 in relation to the low rate of the two previous rainy seasons. The years 1889 and 1895 are apparent exceptions, but once

CHART 1.

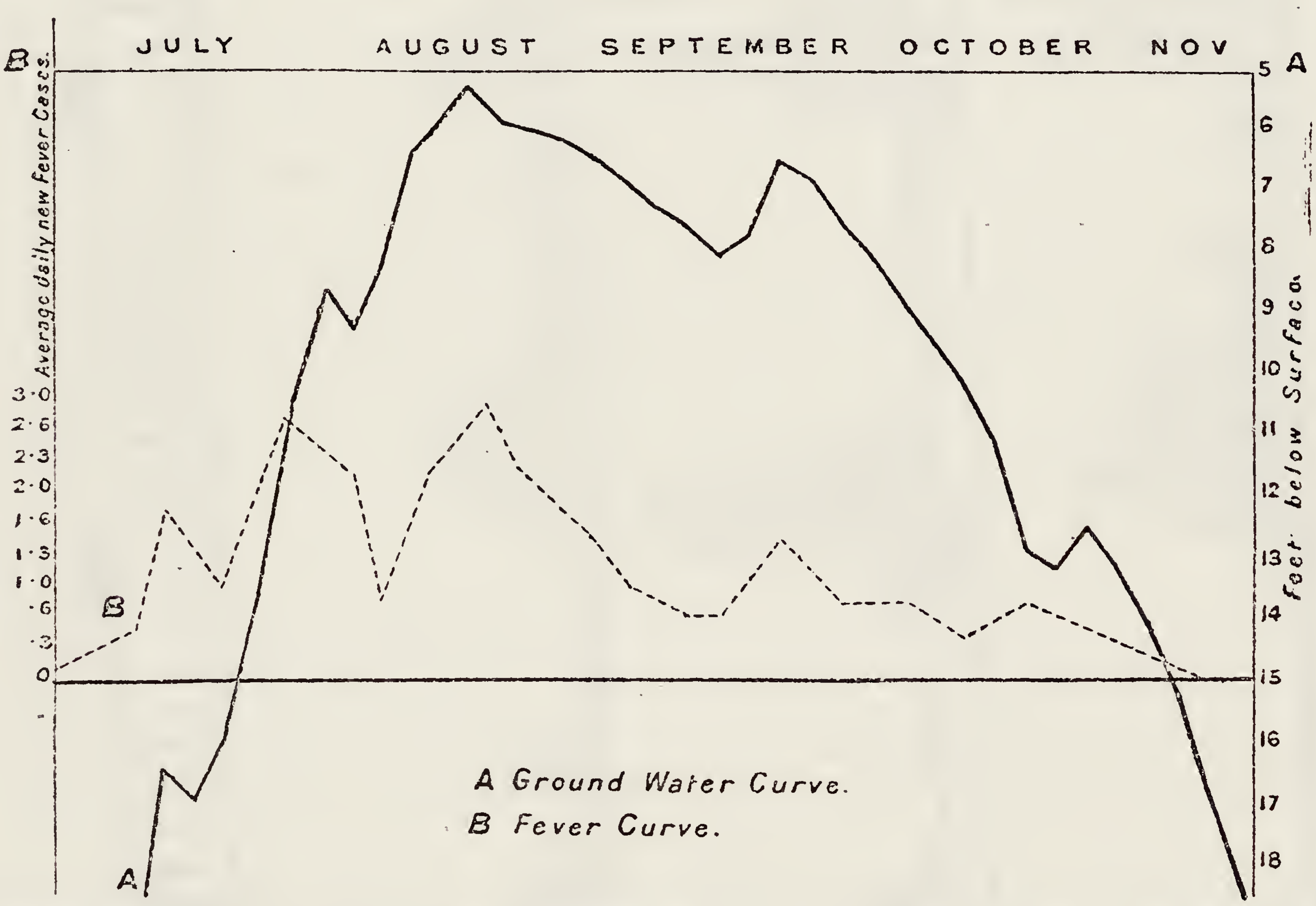


Chart showing the variations in the level of the ground-water and the incidence of fever during four months at Chota Nagpur.

place, it may be pointed out that there was exceptionally little rain in the early months of the year, while the rains of the previous year had both been deficient and had ceased very early, there being no rain whatever in October, a most unusual occurrence. Then the rainfall of 1892 was below the average; and, thirdly, it was most evenly distributed in the different months, so that less than 12 in. fell in any one month. The water-level must therefore have been very low at the beginning of the rainy season of this year and the rains when they came were both deficient and very evenly distributed, so that it is obvious that all the factors which make for a low and constant water-ground level were present during this year, and it is certain that of the whole ten years the water must have remained further from the surface of the ground and have varied less in this than in any other year of the series.

In 1893 the rainfall was very heavy and the fever rate proportionately so, while in 1894 we have the precisely opposite characters to those of 1892—namely, both a very heavy and a very unevenly distributed rainfall, over 19 in. having fallen in both July and August. The consequence was that in this year there was the highest fever rate of any, the water-level having risen so high that it flowed out of the mouth of one of the wells. It may then be said that these charts confirm the previous one in proving that in more they are of the kind which prove the rule, for in these two years, as well as in 1892, a new regiment came to the station early in January and the following figures show that the amount of fever that they suffered from in the early part of the years mentioned was in proportion to the fever rate among them in their previous station, even when that was in a different province :—

Regiment.	Reached Doranda.	Previous stations.	Former fever-rate.	Fever, Doranda.
8th Bengal Infantry.	January, 1889.	Barrackpore and Chittagong ...	480 per 1000	58
12th Bengal Infantry.	January, 1892.	Benares	267·1 per 1000	20
11th Bengal Infantry.	January, 1895.	Bareilly	116·3 per 1000	9

The obvious explanation of these facts is that the cases which occur at the time of the year when the water level is low are relapses from among those men who were attacked during the preceding rainy season. This I found was actually the case in the early part of 1896 in Doranda, for although only 25 per cent. of the men of the regiment suffered from fever in the rainy season of 1895 yet more than

CHART 2.

Chart illustrating the monthly fever-rate and the monthly rainfall over a series of ten consecutive years at Chota Nagpur.

three-quarters of those who had it in the early months of 1886 had suffered from it in the previous rainy season and many of them had had more than one relapse. The incidence of malarial fevers at this spot at different seasons of the year has, then, been satisfactorily explained; but before passing on to my observations in other places I must mention the important fact that at the very time that the ground-water had risen to within 5 ft. of the surface of the ground in the lines occupied by the regiment under observation it was 25 ft. down only 200 yards away and its great rise under the lines was doubtless due to the fact that there was a road along one side of the area which materially interfered with the flow of surface water from it. I have no doubt in my mind that had the lines been situated on the ground where the water always remained 25 ft. or more from the surface there would always have been as little fever among the regiment as there was in the exceptionally dry year 1892. At my suggestion it was proposed to drain the lines more efficiently, but for financial reasons it had not been carried out when I last heard from the medical officer of the station, so I cannot report the result of this measure. This fact (and I have had similar experiences in other places) is of great importance in proving how very local are the conditions which influence the occurrence of malarial fevers; but I shall discuss this point more fully after I have given another instance of it presently.

Now the instance which I have just given of the distribution of the fever in Doranda is at one extreme end of the scale—namely, that of a very dry soil accompanied by a water-level which is very low during the greater part of the year, but rises very rapidly during the rainy season. The other extreme is seen in many of the districts of lower Bengal, which form part of the great delta of the Ganges and Brahmaputra rivers. The greater part of these districts are under water during the rainy season and at this time the fever is at a minimum. When the rains have ceased, however, and the saturated ground begins to dry up again the fever season attains its maximum. Moreover, the ground-water is within a few feet of the surface throughout the year and malarial fevers prevail to a considerable extent in every month of the year, being much more evenly distributed than in Doranda and other similarly situated places. In this case of the flooded districts the maximum fever-rate occurs during the drying-up of the saturated soil, doubtless owing to the rapid evaporation of moisture from the ground carrying up the malarial organisms into the air, when they are breathed in by the inhabitants on or near the drying-up ground. Moreover, the ground-water is always sufficiently near the surface to allow of evaporation going on in the same way throughout the year, although to a less extent than just after the floods have subsided; and so fever is constantly present to a considerable extent and is never absent for long periods, as in places where the ground-water rapidly recedes at the end of the rainy season. This also accounts for the fact which I have observed—namely, that malarial cachexia is much more common in these water-logged places than in the dry ones with low water-level, because in the former frequent re-infections may take place in the same persons throughout the year, while in the latter there is little or no infection except during the four months' rainy season, and although relapses may occur they usually cease long before the next rainy season ensues and so complete recovery takes place before re-infection is likely to occur. Between the two extremes of the very dry places with a low and varying ground-water in which, I believe, infection takes place by the malarial germs being carried up by the air which is displaced by the rising ground-water, as in Doranda, on the one hand, and the water-logged and sometimes flooded regions of the Gangetic delta, where the infection takes place by the organisms being carried up into the air by evaporation of moisture from the soil, on the other hand, there are intermediate places in which both factors play a part in influencing the distribution of the fever. These places are, in fact, by far the most common and also present the most complicated problem, for it is obvious that the two factors may be present in ever-varying proportion, while the denseness or otherwise of the soil will play an important part in influencing the amount of moisture which it will retain and the rapidity and extent of the evaporation which takes place from it.

During a year which I spent in Assam investigating the epidemic malarial fever of that province, which is locally known under the name of Kala-azar, records of the variations of the ground-water were being taken for me in the different districts by the Government, while I was also able to study the incidence of malarial fevers in relation to the variations of the ground-water in the coolie lines of several tea-gardens through the kindness of Mr. Dodds Price and Mr. Lavertine, tea-garden practitioners in the Nowgong district. The data were not quite so accurate as those which I obtained in Doranda, as the exact day on which a coolie came to hospital after getting fever was to some degree dependent on his chances of making extra pay, &c. However, ample evidence was obtained to show that in those places where the water was some considerable distance from the surface before the rainy season commenced the fever rose and fell with the rises and falls of the ground-water, just as it did in Doranda, but as the water was in no case so far down to commence with in the Assam instances as in Doranda, the fever-rate increased during the first month of the rainy season, as the water quickly rose sufficiently to influence it. That this rise was due to the variations of the ground-water and not to other causes, such as changes in the temperature, &c., was proved by the fact that in one instance, in the case of two coolie lines situated only some 300 yards apart, and in other respects similarly placed, there were three rises of both the water-level and of the fever-rate in one of them, while in the same period of time there were only two rises of both in the other line.

Again, it was found that there was most fever in proportion to the number of inhabitants in those lines beneath which there was the greatest and most rapid variations of the ground-water and least in those in which it was most constant in its level. To give an example. In a certain tea-garden there were three coolie lines side by side, but separated from each other by a narrow lake between the upper and middle lines and by a deep depression between the middle and lowest line. Measurements of the water-level in the wells of each line were taken for me twice a week and the fever-rates in the three lines recorded. During the month of July a lot of rain fell and there was a corresponding rise of the ground-water and an increase in the prevalence of malarial fever. The three lines, however, differed considerably in both the amplitude of the variations in the water-level and in the number of cases of fever in proportion to the number of inhabitants of the respective lines. Thus the upper line was situated on ground which was some 10 ft. higher than the other two, which were on just the same level. In this upper line the water varied during this month from 21 ft. to 12 ft. 8 in. from the surface of the ground and the fever was less than in either of the other lines. In the lowest line it varied from 22 ft. to 8 ft. 7 in. from the surface and the fever-rate was somewhat higher than in the first line. In the middle line measurements were taken of three wells, two of which were situated within a few yards of the edge of the tank while the third was fifty yards from it. In the first two the water rose from an average of 14 ft. to one of 4 ft. 6 in., while the third varied from 15 ft. to 8 ft., clearly showing the influence of the tank in raising the level of the ground-water beneath these lines and especially of the part nearest to it. It will also be noted that the water rose nearer the surface in this line than it did in either of the others and in accordance with this the fever-rate was two-fifths greater in this line than in either of the others. On my recommendation it was decided to lower the water in this tank by some 8 ft. or 10 ft., but I have not yet heard the result of the measure, although it could hardly have been otherwise than a favourable one. This, of course, is but an instance of a well-known law, but the accuracy of the data and the very localised variation of the fever-rate in accordance with that of the water-level lend some interest to it.

It was also found that in places where the ground-water was at an intermediate distance from the surface before the onset of the rains, say, from 15 ft. to 25 ft., and the soil was a heavy one which retained a good deal of moisture, then there would first be a rise in the fever-rate with the rise of the water and a fall with the ensuing fall of the water; but if there was then a slight break in the rains and the water-level continued to fall slowly from evaporation of the ground-water, which was still only some 10 ft. or 15 ft. down, there would be another rise in the fever-rate, just as occurs when flooded ground is drying up. Here we have an instance of the two factors successively acting in the same place. Chart III. illustrates this point fairly well. It will be noticed that there were great and rapid variations in the water-level here and that corresponding with them,

only often a few days later, owing to the incubation period of the fever, there were rises in the fever-rate. Further, during the break in the rains corresponding to the slow fall of the ground-water between July 21st and 31st, and again during the final steady fall at the end of the rains from Oct. 9th to Nov. 3rd there are rises of fever corresponding to the times when evaporation from the heavy moist soil would have been taking place. The irregularity at the end of the curve is partly due to the complication of relapses, which are most frequent at the latter exception to the rule that the foot of high hills is very malarious, which I met with in Assam, lends some support to this view. In the north of the Mangaldai district, immediately at the foot of the Himalaya Mountains, are situated some tea-gardens which are remarkably free from fever. On inquiry I found that all the streams from the mountains in this place disappear at the foot of the hills into a sandy soil and appear again along a line just beyond these gardens. They evidently run into a subterranean basin, which must keep at a nearly constant level, and in

CHART 3.

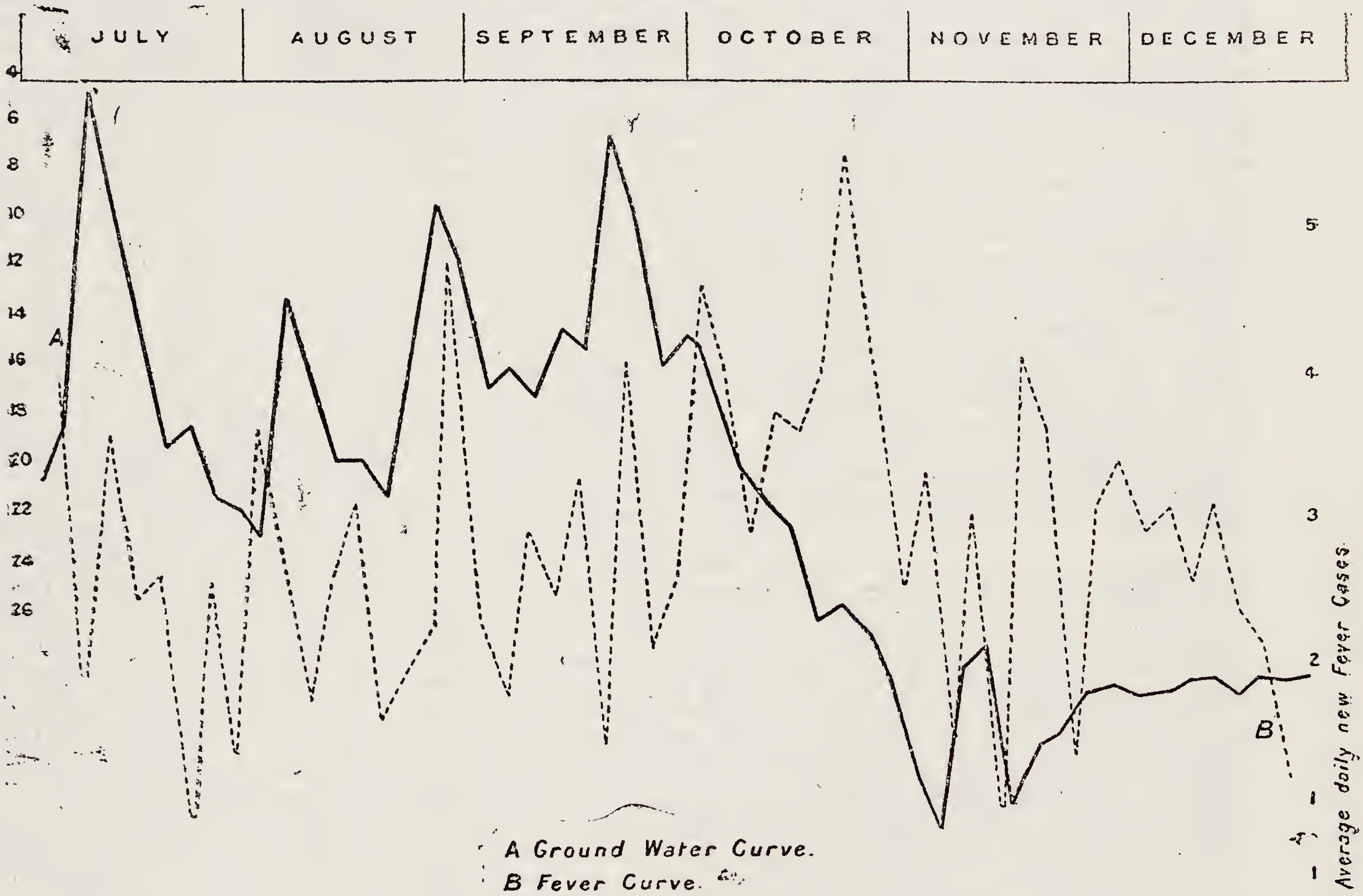
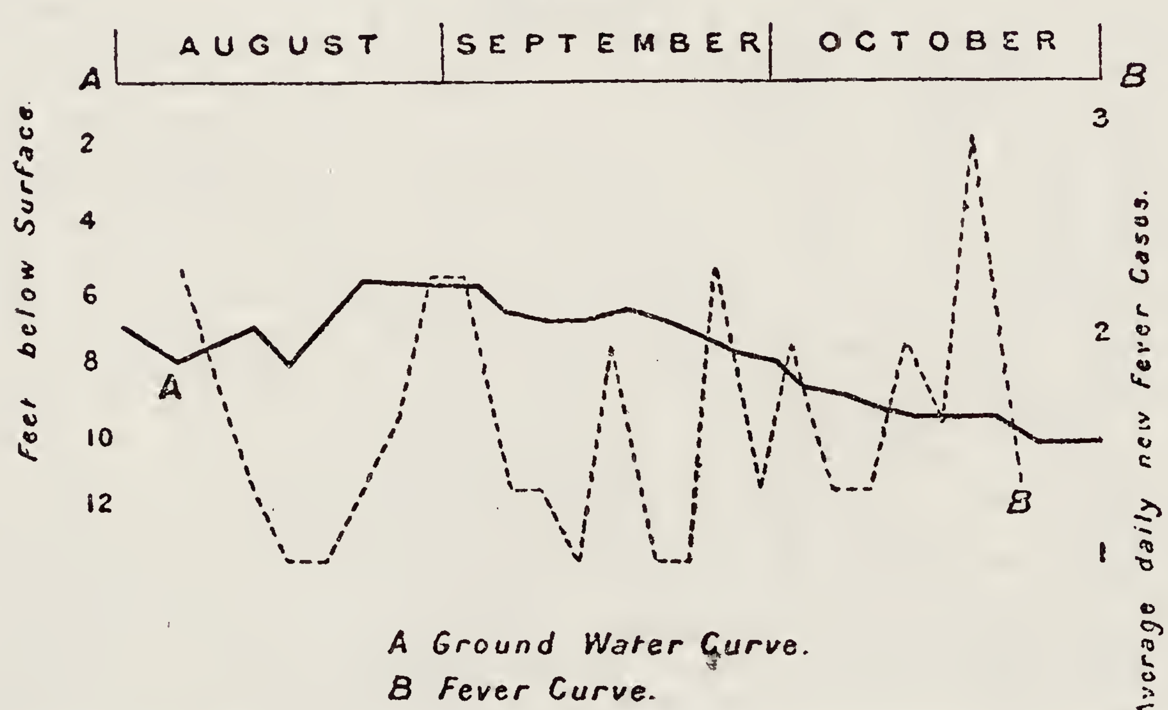


CHART 4.



Charts illustrating the relation of fever incidence (Kala-azar) to ground-water in two Assam tea-gardens.

part of the fever season. It is worthy of note that the garden on which these levels were taken is situated at the foot of some low hills and is a miniature example of the conditions which obtain in terai regions, such as the foot of the Himalaya Mountains, and I would suggest that the notorious unhealthiness of such regions is probably due to the extremely rapid and great variations in the water-level in those parts. A curious example of an apparent one of the lines situate within this area it was found that the level of the ground-water as measured in the wells varied very little and this fact accounted for the absence of the amount of fever which might have been expected in such a terai region.

Chart IV. illustrates the ground-water and fever curves on a garden situated only some twenty miles from that of the last chart, but it presents just the opposite characters. The

upper line represented the water-level and it will be seen that it was remarkably constant only having varied between 5 ft. and 10 ft. from the surface. The fever also varies much less than in the previous chart and although there is a rise with the main rise of the water-level, yet the greater part of the fever occurs during the drying up at the end of the rainy season when the water is slowly sinking. Here, then, the main factor is the evaporation from the saturated soil during the drying up. In Dibrugarh, which is the most easterly part of Assam, the water-level varies between 20 ft. in the dry cold weather to 5 ft. from the surface in the middle of the rainy season, the annual rainfall averaging about 100 in. The fever increases with the rise of the water, but is also high when the soil is drying up after the rains are over, the fall of the ground-water being slow and steady at this time, both factors again coming into play at different parts of the year. In the Punjaub the fever occurs mostly after the rains, but I have no observations on the ground-water level here except in Bunnu on the frontier. In this place the water is more than 50 ft. from the surface even in the rainy season, but it must be remembered that there are no regular rains here. The whole place is, however, irrigated and fever is often seen when fields which have just been irrigated are drying up. Most of the fever occurs on the beginning of the cold weather, when there are great falls in the temperature at night, and is commonest in those who sleep out in the open air and so get chills. This is probably due to such chills coming at just the very time when the system is at its lowest daily ebb, allowing any plasmodium malariæ which may gain access to the body to successfully run the gauntlet of the white blood corpuscles.

So much for the facts that I have to bring forward. I have already mentioned that I believe that the incidence and seasonal distribution of malarial fevers in most places of India can be explained by taking into account both the rainfall and the variations of the ground-water level. Such cases as that of Doranda—in which the entire distribution of malarial fever is dependent on the organisms being carried up into the air by the piston-like action of the rapidly rising ground-water and where the factor of their being carried up by evaporation plays little if any part—only occur in places situated on a rapidly-drying and porous soil, accompanied by a ground-water which is very low for the great part of the year but varies rapidly during the rainy season. This rapid variation of the ground-water level is of great importance in explaining the occurrence of fever in dry places where there is no marshy ground. It also enters largely into the causation of fever in places with an intermediate and varying ground-water and has least influence in places with a constantly high ground-water, in which the factor of evaporation plays by far the largest part.

There are two other points which I wish to refer to which are of considerable importance both from the practical and the theoretical standpoints. They are, firstly, the strictly localised action of the variations in the ground-water level; and, secondly, the light which their discovery throws on the manner in which the infection of malarial fever takes place. Instances of the former have been given both in the case of Doranda and in that of the variations in the fever-rate in the three parallel tea-garden lines. In the first instance there was very little in the conformation of the ground to suggest the great difference in the variations of the ground-water in the areas, which were but some 200 yards apart and the surface levels of which did not differ by more than 3 ft. or 4 ft. Yet in the one spot the water rose to within 5 ft. of the surface, while in the other it remained 25 ft. down. It is well known that sites for camps and cantonments which have been selected by medical officers as the most suitable have had to be subsequently abandoned owing to their proving to be very malarious. I would suggest that before choosing between two or more apparently favourable sites, if a well were first sunk and the variations of the water-level recorded during the rainy season—or, better, for a whole year—it would be found that the one in which the water-level was lowest and varied least would prove to be the least malarious; and it is possible that large sums which have before now been spent in building barracks which have afterwards had to be abandoned on account of their unhealthiness might be saved. Again, such measurements may point to deficiency of surface drainage which was not previously apparent, as was the case in the Doranda lines and the tea-garden tank, the remedying of which might prevent much fever. Secondly, it is evident from the two instances just referred to that the infection arose from the very ground on which the houses of the regiment and of the coolies respectively were built. There is no necessity or reason to suppose that the infection was carried by mosquitoes or any other such medium. The first chart that I have shown can only be explained on the hypothesis that the rise of the ground-water displaces the air from the interstices of the soil and causes the malarial organisms which live in the earth to be carried up into the atmosphere, when they are breathed in by the persons living over the affected ground. The infection probably takes place chiefly during the night, when the powers of resistance will be lowest. In the case of drying-up ground or marsh, again, the infection will be through the air, and I am of the opinion that this mode of infection in malaria is a general one, although it is undoubtedly true that the disease may also be conveyed through water. The fact that all the water in many of the gaols of the Punjaub was for several years boiled without any diminution of the prevalence of malarial fevers also points very strongly to infection through the air being far more common than that through water, while all the facts already given point in the same direction. Any malarial organisms which may be breathed into the lungs have only a very thin layer of tissue to traverse in order to obtain access to the blood, where they live and multiply. It has recently been strongly urged, especially by Dr. Patrick Manson, that these organisms must in some way escape from the body to pass through an extra-corporeal part of their life-cycle. This is very probable, although in the case of ordinary malarial fevers it is equally possible that the germs, which are so widely distributed, may have a complete existence outside the body and are, so to speak, only facultatively parasitic.

In the case, however, of the epidemic communicable forms of malarial fever (such as I have recently shown the Assam disease, locally known as under the name of Kala-azar, to be), it is quite certain that the plasmodium malariæ must in some way escape from the body of one person and gain access to that of another, either directly through the air or—as I think is more frequently the case—after going through the soil. In this way only can be explained the manner in which a man contracts the fever while living in an infected village, and after returning to his own uninfected village while still suffering from the fever members of his household first get it and afterwards others in the village are affected. I will not dilate on this point further in this paper, as I shall be reading one on this epidemic malarial fever before the Royal Medical and Chirurgical Society very shortly, but wish to suggest a possible method of infection in malarial fevers which will explain all the facts that I am acquainted with. It is this. If malarial fever may be contracted by breathing in the malarial organisms, why should they not be also breathed out again when they have completed their work in the body? They have only to pass back again into the alveoli of the lungs and they will be able to escape from these organs more easily than they entered, for the cilia of the air passages will assist their exit. This simple theory seems to me to be much more likely than the elaborate mosquito theory, which is largely based on an analogy between such widely different constituents of the animal scale as the plasmodium malariæ and the filaria sanguinis hominis, while it is also, I think, more in consonance with the known facts as to the incidence and seasonable distribution of malarial fevers. However this may be, it is rather the more practical points of the very frequent dependence of malarial fevers on purely local and often removable variations of the ground-water level on which I chiefly wish to lay stress in this paper and I hope that the evidence I have adduced will afford material for an interesting discussion.

WESTBURY COTTAGE HOSPITAL. — A general meeting of the Westbury (Wiltshire) Diamond Jubilee Hospital Committee was held on Feb. 2nd. The financial statement showed that the subscriptions amounted to £455 and the expenditure to £451. On the motion of Lord Ludlow a hearty vote of thanks was awarded to Mr. and Mrs. Laverton, who had realised £129 from a sale of work by which the hospital was completely furnished and £20 were handed to the medical staff for purchasing necessary appliances.